# *Fischer-Tropsch Catalysis: Fundamentals and Practice*

## A Four-Day Short Course

**July 7-10, 2008, Park City, Utah**

**Instructors: Professors Calvin H. Bartholomew, Professor William C. Hecker, and Dr. Steven LeViness**

**Short Course Packages, Dates, and Tuition**

| Package | Dates | Tuition[a] |
|---|---|---|
| A. *Fischer-Tropsch Synthesis: Fundamentals and Practice* (including a substantial introduction to fundamentals of heterogeneous catalysis) | July 7-10 | $2,000 |
| B. First half, *Fundamentals of Catalysis*[b] | July 7-8 | $1,400 |
| C. Second half, *Fischer-Tropsch Catalysis*[c] | July 9-10 | $1,400 |

a. Tuition for professionals as shown; academic discounts of 30, 40, and 50% for faculty, post doctoral fellows and students respectively.

b. Package B is intended for attendees desiring only an introduction or review of the fundamentals of catalytic science.

c. Package C is intended only for attendees already highly trained, experienced and current in the fundamentals of heterogeneous catalysis and desiring training in the fundamentals and applications of FTS.

**Course Description:** An introductory four-day course which combines the basics of catalysis with the science and technology of Fischer-Tropsch synthesis (FTS); designed for engineers and scientists (B.S., M.S. or Ph.D. levels) with previous experience and training in chemistry and materials but little or only modest experience in heterogeneous catalysis and FTS. Lectures during the first two days will emphasize more general fundamentals of catalysis and kinetics; lectures on the following two days will focus on fundamentals and practice of FTS. Students will (1) participate in lectures, discussions, and reviews; (2) receive copies of the leading textbook on fundamentals and practice of catalysis and a set of comprehensive lecture notes; and (3) be given training that will help them become well-grounded in fundamental aspects of heterogeneous catalysis important in FT catalyst design, preparation, characterization and testing.

**Course Objectives:**

1. Student will gain a basic knowledge of kinetic tools, adsorption, catalytic surface reactions, pore diffusion, mass transfer, laboratory and industrial reactors and their application to heterogeneous catalytic processes.
2. Student will become familiar with methods and tools used to evaluate catalysts.
3. Student will learn the most important scientific and technological aspects of FT catalysis, including process chemistry, kinetics, mechanisms, catalyst design, catalyst deactivation, reactor design and process design.
4. Student will learn principles and state-of-the-art methods for characterizing and testing FT catalysts.

**Course Topics (four per day):**

1. Introduction ("The Magic of Catalysis"), definitions and rules of kinetics, rate equations
2. Kinetic tools: Elementary steps, the steady state and rate determining step approximations
3. Adsorption: theory, thermodynamics, isotherms, kinetics, chemisorption, dispersion
4. Catalyst materials, properties, and preparation
5. Kinetics of surface reactions, theory and principles, Langmuir-Hinshelwood approach, BET isotherm and application
6. Kinetics of heterogeneous catalytic reactions, structure-activity relationships: principles, applications, recent studies, structure-sensitivity, support effects.
7. Mass transfer and pore diffusion in catalysts: equations and criteria
8. Ideal reactors and reactor design: basic principles and application
9. Introduction: brief history of FT synthesis, important developments in catalyst and process technologies; overview of coal- and natural-gas-based processes; the future of the growing GTL and renewables markets.
10. FTS reaction chemistry, selectivity models
11. FTS kinetics, mechanisms, and models
12. FT catalyst design: principles, approaches, promoters, supports, preparation
13. FT catalyst characterization and testing
14. FT catalyst deactivation and regeneration: problems, principles for prevention
15. FT reactor technologies, design, and modeling
16. FT process technologies, design, and economics

**Course Materials:**

1. C.H. Bartholomew and W.C. Hecker, *Fischer-Tropsch Catalysis: Fundamentals and Practice*, Course Notes, June 2008.
2. C.H. Bartholomew and R.J. Farrauto, *Fundamentals of Industrial Catalytic Processes*, 2nd edition, John Wiley, 2006.

**Learning Format**

Daily learning activities will consist of four 90 minute lectures each followed by a 15-min review and discussion; short breaks for refreshments and informal discussion will occur mid-lecture and post-lecture. On one or two days we will follow the Gordon Conference format, i.e., two topics will be presented in the morning, one in the early afternoon after lunch, and one in the evening. Thus, much of the afternoon will be reserved for recreational activities and informal discussions. Our philosophy is that learning should be fun, and our courses have the reputation of being highly informative, stimulating, entertaining, and enjoyable.

**Activities**

Tentatively planned activities will include a tour of the Park City Olympic Park, a desert receptions, and an course dinner. You and your family members can enjoy the panoramic vistas

of the Wasatch Rocky Mountains before, during and following the course. Park city (site of the 2002 Winter Olympics) includes some of America's newest and greatest alpine resorts and recreational facilities. Your family can be pleasantly occupied nearby with hiking, biking tours, horseback riding, hot air ballooning, fishing, boating, rafting, golf, summer concerts, shopping in Historic Park City, riding the alpine slide, and/or touring the Olympic Park. Further travel and recreational information can be found at http://www.parkcityinfo.com.

**Lodging:** We are presently negotiating a mountain venue in either Deer Valley or the Canyons just above Park City. Summer rates of only $130-160/night will apply to single/double rooms.

**Catalyst Deactivation Instructors:**

**Calvin H. Bartholomew,** Professor of Chemical Engineering at Brigham Young University (BYU) has taught courses at BYU on kinetics, materials, and catalyst deactivation during the past 35 years. He is an active researcher in heterogeneous catalysis and a recognized authority on catalyst deactivation (over 120 journal articles, 20 chapters, and 3 books). He is co-author with Dr. Robert Farrauto of Engelhard of *Fundamentals of Industrial Catalytic Processes*, a leading handbook and textbook on this subject. Together with Professor Bill Hecker, he has taught short courses on "Heterogeneous Catalysis" and "Catalyst Deactivation" to more than 600 professionals from industry and academe. Professor Bartholomew has worked at Corning Inc., UniCal, and Sandia National Labs and has consulted with more than 40 companies.

**William C. Hecker**, Associate Professor of Chemical Engineering at BYU has taught courses on kinetics, catalysis, air pollution control and heat/mass transfer since 1982 and has conducted research on automotive catalysts, NO reduction, and coal char catalysis. He also worked at Chevron, Dow Chemical, Exxon, and Occidental Research.

**Stephen LeViness**, Technical advisor in GTL Technology at Schlumberger, based in Tulsa OK. Prior to that Technical Director in the area of Fischer-Tropsch reactor technology at Syntroleum Corporation, also in Tulsa, since June 1999. Served as program manager for the FT literature compilation and publication website project, www.fischer-tropsch.org, from 2000-2007. From July 1998 to June 1999 Engineering Advisor for Fischer-Tropsch process development at Mobil's Upstream Strategic Research Center in Dallas TX. And from 1989 through 1998 worked at Exxon Research and Development Laboratories in Baton Rouge, Louisiana as a staff engineer in Exxon's AGC-21 gas-to-liquids process R&D program from 1991 through 1998. BS and MS in chemical engineering from Worcester Polytechnic Institute (WPI), and a Ph.D. in the same from Rice University.

**Preliminary Registration and Contacts**

Enrollment will be limited to 30 participants. Given the current interest in Fischer-Tropsch and our experience in 2006 & 2007, the class will probably fill up within 3-4 weeks. Please notify Professor Bartholomew *as soon as possible* at calb@byu.edu or his secretary, Brad Hancock, at littlerubberducky@gmail.com, if you are planning to attend. Registration will be cut off on or before May 31st. You can ensure your enrollment by sending a preliminary registration fee in the form of a $500 check to Professor Calvin H. Bartholomew, Department of Chemical Engineering, 350 CB, Brigham Young University, Provo, Utah 84602. Additional information will be posted at http://www2.et.byu.edu/~bartc/.